Know Your Audience: Effectively Communicating the Results of a Pre-engineering Program

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Abstract

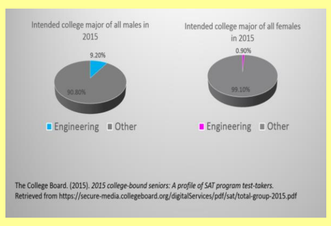
A female's college and career goals may ultimately be restricted by declining interest and achievement in mathematics that originates during her pre-high school years. This researcher examined how a piloted pre-engineering program in one eighth grade middle school team impacted adolescent girls' interest and achievement in mathematics. The results suggest that Project Lead The Way (PLTW) impacted both boys' and girls' interest and achievement in mathematics. In five of seven attitude scales, PLTW had a positive effect on gender that was not paralleled in the control group. When achievement was considered, differences in growth levels between the two groups were statistically significant in six of the 11 standards in the experimental group. As this educational research was undertaken to assist local decision makers in supporting or opposing a district adoption of PLTW for all middle school students, effectively communicating the results to the various stakeholders in an engaging, useful manner was paramount.

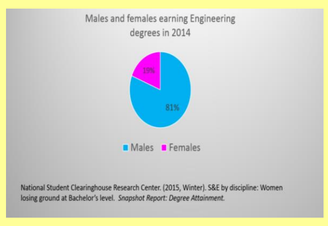
Study Purpose

Research Question:
Does the pre-engineering program Project Lead The Way (PLTW) positively influence a middle school girl's interest and achievement in mathematics as assessed by Fennema-Sherman Mathematics Attitude Scales, Blue Ribbon Testing© scores in Mathematics, student and teacher focus groups, and classroom observations?

A secondary purpose was to assist local decision makers in supporting or opposing a district adoption of PLTW for all middle school students. Thus, effectively communicating the results to the various stakeholders in an engaging, useful manner was paramount.

Why is it so important that we increase the number of women in STEM, particularly engineering, fields? As females bring different life experiences to the table by virtue of their gender, the field of engineering, as well as other male-dominated domains, suffers in the end from opportunities lost when women are not part of the innovation teams.





Theoretical Framework: Nature vs. Nurture

Biological theoretical perspectives suggest that math achievement is tied to the gender one is assigned at birth. Possible biological causes of discrepancy among boys' and girls' achievement (ability) in mathematics include: iron deficiency; spatial visualization: speed of math fact retrieval; and brain structure.

Social theoretical perspectives state otherwise. These propose that attitudes impact achievement, as confidence, expectations, and attributing success to ability rather than effort are factors that contribute to discrepancies in boys' and girls' math abilities and scores (Ai, 2002; Atweh, Forgasz, & Nebres, 2001; Stipek & Gralinski, 1991). Possible causes of discrepancy among boys' and girls' attitudes towards mathematics include: math anxiety; lower levels of confidence; teachers' attitudes, expectations, and treatment of students, including questioning patterns; stereotype threat; and presence of males.

A **growth mindset** can be encouraged through a female's engagement in gender-neutral programs that include specific features (Dweck, 2006, 2008; Boaler, 2016). STEM programs which engage females may serve to foster both achievement in, and positive attitudes towards, mathematics.

Methodology

Sample and Participant Selection
- 299 eighth graders in the school placed on 3 teams
- Teams were created randomly by guidance counselors the spring preceding the pilot school year
- 179 eighth graders in the study: control group (99) & experimental group (80) – 2 teams
- Average ability levels of the experimental group girls (and boys) were the same as on the other two teams (checked at beginning of study again)
- one class of seventh graders also participated, whose data was not included in the study

Treatment (Program)
- 4 marking periods of PLTW replaced 2 marking periods of art, 1 marking period of computers, and 1 marking period of family and consumer science on one 8th grade team (experimental group) over the course of a single school year
- Design and Modeling and The Science of Technology were the 2 PLTW Gateway To Technology modules delivered.
Math curriculum was the same on both teams

Data Collection
- Blue Ribbon Testing© scores in mathematics in fall and spring
- 7 of the 9 Fennema-Sherman Mathematics Attitude Scales administered in fall and spring
- student focus groups in spring
- classroom observations in spring
- teacher focus groups in spring

Conclusions and Implications

- Addressing middle school mathematics achievement, when there is no gap (as illustrated in national and local data), by nurturing positive attitudes towards it, may be the best way to prevent the attitude and achievement gap that clearly still exists at the high school level.
- The empirical research outcomes of this and other action research must be communicated to the research community, as well as shared with educational leaders and stakeholders, in multiple formats, including engaging visual representations, so that decisions regarding program adoption, funding, and support may be justified.
- School leaders, as change agents, have a moral responsibility to implement innovative programs that will address the inequities inherent in the mathematics education of females in the United States that persist into the 21st century.

Reference

Paslov, L. (2016). Impacting middle school girls' interest and achievement in math: Research on a piloted pre-engineering program. *Proceedings of the Northeastern Educational Research Association Annual Conference*.)
http://digitalcommons.uconn.edu/nera-2016/1/

Results

STANDARD	BEGINNING OF SCHOOL YEAR WHICH GENDER SCORED HIGHER?	END OF SCHOOL YEAR WHICH GENDER SCORED HIGHER?
Number Sense	M	M
Operations	M	M
Estimation and Approximation	M	M
Ratio, Proportion, and Percent	M	M
Measurement	M	M
Spatial Relationships and Geometry	M	M
Probability and Statistics	M	F
Patterns	M	M
Algebra and Functions	M	F
Discrete Mathematics	M	F
Integrated Understandings	M	F

Figure 1. Gender of experimental group students whose mean average in each standard of Blue Ribbon Testing was higher.

Box 2 – What Do Teachers Do in Classes to Make Math Interesting?

"Projects, *Project Lead The Way*, a page out of Mrs. O's [4th-6th grade math teacher] book, tie-in activities, like the trip to the Final Four thing – that was cool!"
Experimental Group Student #6 (male)

"Usually teachers try to, in other classes, like social studies and stuff like that, they usually try to put it to a story or something, or try to involve something fun."

"In social studies we did the Stock Market. That was about selling, buying, adding up all your stocks, stuff like that. That was pretty cool."

"And awesome."
Control Group Students #7, 8, 9 (males)

"And a lot of things in elementary school would be, like, hands-on, and we could see it, it would be right in front of us and we'd know what to do with it. But like now we're just learning off the board and we can't really take it all in… because it's not in front of us…"
Experimental Group Student #10 (female)

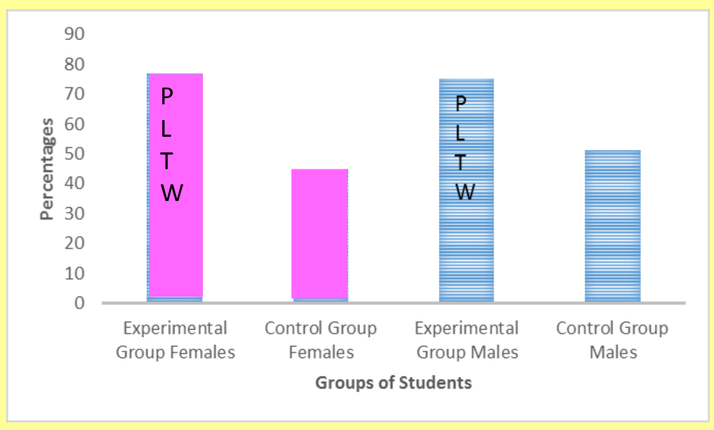


Figure 2. Percentage of students improving or maintaining scores on six or more standards of Blue Ribbon Testing by group and gender.

Figure 4. Frequency of words used by students to describe what they thought teachers did in their classes to make math interesting, with the size of each word indicating its frequency or importance.

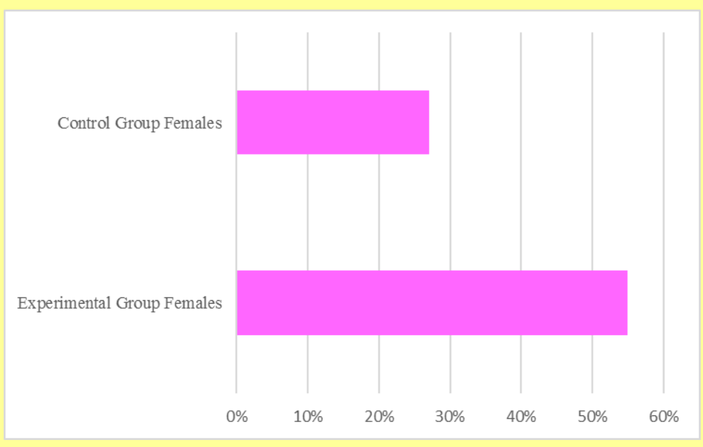


Figure 3. Percentage of females indicating a like or love of mathematics at the end of the school year by group.

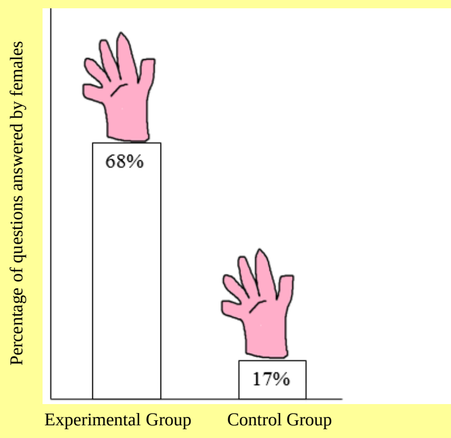


Figure 5. Percentage of questions posed in mathematics classes answered by females at the end of the school year, by group.